Copper Mold Materials

for the Plastics Industry

A ThyssenKrupp Services company

ThyssenKrupp Materials NA

Copper and Brass Sales Division

ThyssenKrupp

Copper Mold Materials

ThyssenKrupp Materials NA, Copper and Brass Sales Division, is a major supplier of nonferrous materials for the plastics molding industry including the full line of MoldMAX high performance copper alloys from Brush Wellman, Inc.

All of the items described here are stocked by Copper and Brass Sales. This means that the entire range of alloys, shapes, and sizes is ready and available for fast shipment to you from one of our many service centers located throughout North America.

In addition to large dependable stocks of materials, our service doesn't stop when your order is placed. Our value-added operations provide plate sawing of mold materials in thicknesses up to 40 inches. Standard sawing services with precision tolerances are also available. This saves you time and money by minimizing your need for costly additional machining.

Our full line of copper alloy mold materials features the following high performance products:

MoldMAX HH® (High Hardness) is the premier copper mold alloy. This alloy has a hardness and strength comparable with standard tool steels but its thermal conductivity is at four to six times higher. MoldMAX HH® is used for injection mold cores and cavities and blow mold pinch-offs. Its high hardness provides durability in applications where other high conductivity copper alloys fail. The alloy resists galling against other mold alloys, including itself.

MoldMAX LH® (Low Hardness) is a premium copper mold alloy that provides hardness and strength comparable with standard AISI P-20 tool steel and a thermal conductivity five times higher. MoldMAX LH® is used for injection mold cores and cavities where moderate hardness and high toughness and conductivity are required.

MoldMAX SC® is a high conductivity copper mold alloy with good strength. MoldMAX SC® is used as blow mold cavities, injection mold cores and cavities and hot runners. The alloy provides excellent toughness, and the highest conductivity of any alloy with tensile strength in excess of 100,000 psi.

MoldMAX XL® is a high strength copper mold alloy with good thermal conductivity. The alloy contains no beryllium and is available in sections as large as 12" thick. The alloy's hardness is comparable with AISI P-20 tool steel, but its thermal conductivity is two to three times higher. MoldMAX XL® is used as injection mold cores and cavities. The alloy provides excellent toughness, wear resistance and surface finish. MoldMAX XL® typically machines faster than tool steels, and with appropriate machine tools, metal removal rates several times higher can be obtained.

MoldMAX V® (MMV) is a high conductivity, moderately high strength, copper nickel silicon chromium alloy. Applications include injection mold and blow mold cores and cavities.

C18000 is a high conductivity, good strength, copper nickel silicon chromium alloy. Applications include injection mold inserts and blow mold pinches.

For more information or to place an order, call our nearest service center toll-free at (800) 926-2600.

For more detailed technical information or additional applications assistance, contact Douglas B. Zeug, Mold Material Specialist, at (616) 242-5107, or by e-mail at Douglas.Zeug@thyssenkrupp.com.

Stock Shapes and Sizes

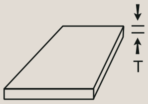
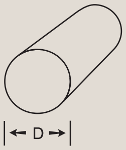


Plate Alloys	Thickness Range (Inches)
MoldMAX HH	1/4 — 12
MoldMAX LH	1/4 — 12
MoldMAX SC	3/4 — 3-1/2
MoldMAX XL	12
MoldMAX V	1 — 4
C18000	1/2 — 6



Round Rod	Diameter Range (Inches)
MoldMAX HH	1/2 — 8
MoldMAX SC	1/2 — 4
MoldMAX XL	1 — 4
MoldMAX V	1 — 4
C18000	5/8 — 3-1/2

Comparative Characteristics of Copper Mold Materials

Typical Properties		Yield Strength (ksi)	Tensile Strength (ksi)	Elongation %	Hardness	Thermal Conductivity (BTU/ft/hr/°F)	Coefficient of Thermal Expansion (x 10^{-6}/°F)	Density (lb/in³)	Modulus of Elasticity (x 10^{-6} lb/in²)	Charpy V-Notch Impact Strength (ft-lb)
MoldMAX HH	Beryllium Copper	145	170	5	36-42 HRC	75	9.7	0.302	19	4
MoldMAX LH	Beryllium Copper	110	140	15	26-32 HRC	90	9.7	0.302	19	12
MoldMAX SC	Beryllium Copper	105	115	15	20-24 HRC	145	9.3	0.319	20	15
MoldMAX XL	Copper Nickel Tin	105	125	6	30 HRC	40	9.7	0.323	17	4
MoldMAX V	Copper Nickel Silicon Chrome	90	105	7	28 HRC	92	9.8	0.314	22	40
C18000	Copper Nickel Silicon Chrome	75	95	20	16 HRC	135	9.7	0.32	16	35

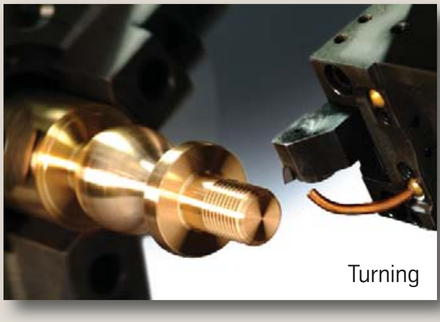
Milling (roughing)

MoldMAX	Tool Material	Cutting Speed (sfm)	Feed Rate (in./tooth)	Depth of Cut (in.)
HH	C-2 Carbide	375-800	0.004-0.015	0.1-0.2
LH	C-2 Carbide	500-1000	0.004-0.015	0.1-0.2
V	C-2 Carbide	350-500	0.003-0.006	0.1-0.2
XL	C-2 Carbide	800-2400	0.005-0.015	0.1-0.15
SC	C-2 Carbide	800-2000	0.005-0.008	0.1-0.15


Milling

Milling (finish)

MoldMAX	Tool Material	Cutting Speed (sfm)	Feed Rate (in./tooth)	Depth of Cut (in.)
HH	C-2 Carbide	400-1500	0.001-0.003	0.1-0.10
LH	C-2 Carbide	500-1500	0.001-0.003	0.1-0.10
V	C-2 Carbide	400-1500	0.001-0.004	0.1-0.10
XL	C-2 Carbide	800-2400	0.001-0.005	0.1-0.10
SC	C-2 Carbide	800-2000	0.001-0.005	0.1-0.10


Turning

Drilling*

MoldMAX	Tool Material	Cutting Speed (sfm)	Feed Rate (in./tooth)
HH	Cobalt Steel	100-300	0.002-0.009
LH	Cobalt Steel	100-400	0.002-0.009
V	Cobalt Steel	125-200	0.002-0.007
XL	Cobalt Steel	150-500	0.002-0.005
SC	Cobalt Steel	125-500	0.002-0.005

*The high conductivity of MoldMAX alloys may result in the drill bit binding. Grinding the point slightly off-center may alleviate this problem.

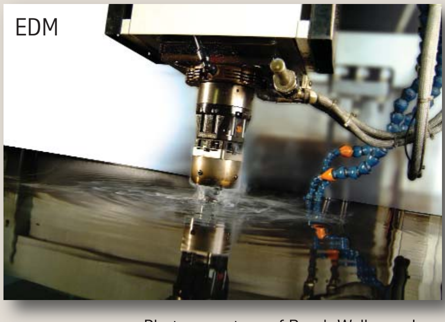
Turning

MoldMAX	Tool Material	Cutting Speed (sfm)	Feed Rate (in./tooth)
HH	C-2 Carbide	900-1200	0.01-0.02
LH	C-2 Carbide	1200-1500	0.01-0.02
V	C-2 Carbide	900-1400	0.003-0.010
XL	C-2 Carbide	1200-3000	0.01-0.02
SC	C-2 Carbide	1500-2000	0.01-0.025

Sink EDM*

MoldMAX	Electrode*	Polarity	Current	Voltage	Duty Factor	Estimated Burn Rate
HH	Copper	Negative	50	220	50%	2 cm./hr.
LH	Copper	Negative	50	220	50%	1.8 cm./hr.
V	Copper	Negative	60	220	50%	1.8 cm./hr.
XL	Copper	Positive	40	110	90%	2.5 cm./hr.
SC	Copper	Negative	50	220	50%	1.3 cm./hr.

*Graphite electrodes can be used, but wear rates may be up to 2-4 times greater.


EDM

Photos courtesy of Brush Wellman, Inc.

MoldMAX HH®/LH® and MoldMAX SC® (PROtherm®)

Surface Preparation
Best results are obtained with a clean surface, free of dirt, oil, paint, grease, tarnish and oxide. Conventional cleaning, such as solvent or vapor degreasing, is effective in removing organic contaminants. Aggressive brushing, abrasive blasting, or acid pickling is required for adherent contaminants such as oxides.

Cleaned parts should be welded immediately. If a delay is unavoidable, they should be stored in a protected environment away from shop dust, acid and sulfurous or ammonia fumes.

Filler Metal
Beryllium copper rod should be used as the filler metal in welding beryllium copper to other metals or to itself. Beryllium copper alloy C17200 (Brush Alloy 25) rod is available in all common gauges, with 3/32 and 1/8 inch (2.38 and 3.18 mm) the most widely used as filler stock. Wire coil, including fine wire, is also available. Both the high strength and high conductivity beryllium copper use C17200 filler. Alternatively, an aluminum bronze filler (ERCuA1-A2) is often used in welding beryllium copper to steel. Filler metal must be clean, and should be stored in a fume-free environment.

When high conductivity beryllium copper is welded using alloy C17200 filler, it is necessary to homogenize the part at 1475-1550°F (800-850°C) to prevent cracking during subsequent solution annealing.

Arc Welding Procedures
Because of the formation of refractory beryllium oxide films, the gas shielded arc welding techniques offer the only successful methods for fusion welding beryllium copper. With a matching filler metal, both TIG (GTAW) and MIG (GMAW) welding are suitable. TIG is commonly used for sections up to about 0.25 inch (6 mm) thick, while MIG welding is widely used for up to 2 inch (50 mm) thick material. Thin strip, less than 0.04 inch (1 mm) thick can be butt welded using the TIG torch only (without filler) or fine wire MIG. In general, the high thermal conductivity of copper alloys may necessitate preheating the work to maintain fluidity in the weld pool. When preheating is required, 400°F (200°C) is usually adequate.

For shielding gases, welding grade (low oxygen) argon or helium are used, either alone or mixed. Carbon dioxide is not used, and nitrogen is used only in mixtures. Gas mixtures provide improved heat input, higher speeds, deeper penetration and improved weld quality.

Thin section beryllium copper may be square butt welded, but thicknesses above 3/16 inch (4 mm) require a 60-90 degree V butt or a U butt. A 1/16 inch (1.15 mm) root gap should be allowed in all sections thicker than 1/16 inch. Periodic tack welds will prevent distortion and misalignment in long welds. Flange or lap weld configurations are desirable, and horizontal welding is always preferred because of the high fluidity of the beryllium copper weld pool. When welding beryllium copper to other metals, the formation of complex phases in the weld can be minimized with small weld pools, characteristic of pulsed MIG welding.

The TIG welding electrode is a sharp thoriated tungsten rod designated EWTh1 or EWTh2. An AC power source is usually preferred because the weld pool agitation assists in dispersing the oxide for smoother welding conditions and better welds. For use with a DC source, the straight polarity (electrode negative) condition carries higher current and prevents electrode erosion. The control afforded by TIG welding is well suited for small local repair work.

The high metal deposition rate in MIG welding favors this procedure for thick sections and larger jobs. The power source is DC, electrode positive. Typical MIG welding conditions are 24-32 volts, 250-450 amps, 0.5-1.0 in3/min (10-15 cm3/min) wire feed rate, 50-10 liters/min argon flow rate. For beryllium copper, the high side of the manufacturer's recommended amperage range for copper alloys should be used for finer, more uniform metal transfer.

MoldMAX XL® Weld Repair

Weld repair allows tool repair or design changes to be carried out. MoldMAX XL® can be repair welded and areas of the mold can be built up. Welding procedures outlined below apply to the Gas Tungsten Arc Welding (GTAW) process utilizing MoldMAX XL® welding rod available from Brush Wellman. Welding with other filler materials, such as copper alloys, or even tool steel, may be possible but has not been studied.

The area to be welded should be prepared by removing any surface deposits, fluids, etc., that could contaminate the weld. Cracks should be prepared by pre-machining all evidence of the crack and rounding all edges. Welding electrodes should be 1/8 inch diameter, 2% thoriated tungsten with a pointed tip (20-25 degree included angle). Argon is the recommended shielding gas at a flow rate of 25 cfh. Preheat and interpass temperatures should be limited to 300°F. Direct current electrode negative polarity and current levels of 180 to 200 amps are recommended.

The weld, in the as-welded condition, will exhibit a heat affected zone of lower hardness than the surrounding material. Hardness levels may be restored to Rc 25, without affecting the hardness of the base metal, by following the recommended post weld heat treatment. The welded component should be heated to 740°F (±10°F) for a period of 180 minutes. The post-weld heat treatment should be tightly controlled. Once the piece has been at the recommended temperature for the recommended time, allow it to air cool to room temperature.

If extensive welding is to be carried out — for example, a major design change — consider replacing the affected area with an insert of MoldMAX LH® especially in an area of the tool that is expected to be damaged repeatedly. Alternatively, carry out the post-weld heat treatment periodically and keep the component temperature under 300°F when welding.

Industrial hygiene precautions for welding should be followed in accordance with the Material Safety Data Sheet for this material.

CDA 180

GTAW (TIG) Procedures
Preheat: 500°F (necessary only if piece is large)
Gas: Helium at a flow rate of 45-55 cfh, or argon at a flow rate of 20 cfh
Current: AC or DC, straight polarity
Amperage: Varies, depending on size of piece and application
Voltage: 5-25 (automatic on GTAW welding machines)
Tungsten Diameter: 3/32"-1.8"
Filler Rod Diameter: 1/16"-3/32"

Types of Filler Rod
Several types of filler rod may be used successfully. The best and easiest to apply are any of the AMPCO-TRODE® rods. Hardness and application desired will dictate which is most appropriate. For a higher localized hardness, 420SS or 17-4SS may be used with great success. This will result in a much higher hardness in a localized area, but will maintain outstanding thermal conductivity. Stellite may also be used in certain applications.

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